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Agroecological Practices and Symbolic Communication in Bajau Coastal Communities: Pathways to Sustainable Fisheries and Rural Development

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Coastal and marine ecosystems are crucial for maintaining food security, ecological balance, and rural livelihoods, yet they are increasingly threatened by human exploitation, habitat degradation, and climate change. These pressures threaten the cultural and ecological integrity of traditional maritime communities such as the Bajau, whose livelihoods are closely tied to coastal resources. This study explores how Bajau's symbolic communication and agroecological knowledge contribute to sustainable fisheries management and coastal ecosystem conservation. Using a qualitative ethnographic approach within a post-positivist paradigm, the research was conducted in Muslim Bajau settlements along the Tiworo Strait, Southeast Sulawesi, involving 31 key informants selected through purposive sampling. Data was obtained through semi-structured interviews, participant observation, and field documentation, and analyzed using an interactive model consisting of condensation, categorization, interpretation, and verification. The findings reveal that Bajau ecological governance integrates spiritual-ethical values, traditional ecological wisdom, and community-based management principles within an integrated coastal agroecological system—encompassing fisheries, mangrove management, and nearshore resource management. Three interrelated dimensions underlie these practices: Islamic ecological wisdom, symbolic communication, and intergenerational knowledge transmission. Rituals, taboos, and traditional fishing practices serve as moral-educational mechanisms that strengthen ecological awareness, ethical behavior, and collective responsibility towards nature. Theoretically, this study advances understanding of the interconnections between spiritual beliefs, cultural practices, and environmental governance in maritime communities. Practically, this study offers a replicable model for community-based coastal management that aligns moral values with adaptive ecological strategies. Policy implications emphasize the integration of cultural ethics, symbolic communication, and local ecological knowledge into coastal resource planning to enhance socio-ecological resilience and food security in maritime areas.

Keywords: Marine ecosystems, biodiversity, livelihood, agroecology, coastal management, food security, traditional knowledge, sustainable rural development.

INTRODUCTION

Coastal and marine ecosystems boast high biodiversity and play a crucial role in supporting food security, agroecological systems, and local livelihoods. Agricultural activities such as tidal rice paddies, rain-fed fields, and seaside gardens are heavily influenced by coastal dynamics, including saltwater intrusion, tidal flooding, and the degradation of protective vegetation such as mangroves and seagrass meadows (Si et al., 2025). However, these ecosystems face pressures from land conversion, resource exploitation, and climate change. The Food and Agriculture Organization (FAO) reports that more than 600 million people worldwide depend on coastal resources for food, economic development, and cultural identity (Food and Agriculture Organization, 2022). Threats such as ocean acidification, overfishing, mangrove loss, coral reef degradation, and increasing salinity of agricultural land threaten the biodiversity, socio-economic resilience, and

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adaptive capacity of coastal agroecosystems to climate change (Rahmat et al., 2025; Kurniawati et al., 2025; Schröter et al., 2020). In this context, the coastal agroecology approach emerged as a transformative strategy for integrating ecological resilience with agricultural productivity, while strengthening the balance between humans and the environment. This approach emphasizes the importance of integrating ecological balance, community participation, and utilizing local wisdom in managing sustainable agricultural and fisheries systems (Momin et al., 2025; Bezner Kerr et al., 2023). Coastal agroecology seeks to build resilient food systems by restoring coastal ecological functions and strengthening communities' adaptive capacity to environmental change.

Indonesia serves as a vivid example of both the complexity and urgency of implementing this approach. In Southeast Sulawesi Province, particularly in the Tiworo Strait region, the link between coastal ecology and socioeconomic dynamics is particularly strong. Over the past two decades, unregulated fishing activities, pollution, and habitat degradation have led to a decline in fish stocks of approximately 30%, accompanied by coral reef damage and reduced mangrove cover (Boni et al., 2024). These ecological pressures have also weakened traditional governance systems that previously functioned as mechanisms for regulating marine resource use based on community norms and rituals.

Amid these challenges, the Bajau people—one of the region's Muslim maritime communities—still maintain a complex system of traditional ecological knowledge as the basis for natural resource management. Through cultural mechanisms such as seasonal migration (*bapongka*), customary prohibitions (*pamali*), and sea thanksgiving rituals (*maduai pinah*), the Bajau people instill an ecological ethic integrated into their social and spiritual fabric (Basri et al., 2024; Gada, 2024; Yusuf & Marjuni, 2023). These practices reflect a community-based resource management model that can be categorized as a form of coastal agroecology, as it combines spirituality, ecological adaptation, and fisheries sustainability within a unified socio-ecological system.

Modernization, market expansion, and generational change have gradually weakened the transmission of traditional ecological knowledge among the Bajau people (Zainuddin, 2023; Zamzami et al., 2025). Previous studies have largely focused on maritime identity, adaptation strategies, and the socio-economic marginalization of Bajau communities (Maharani, 2025; Majumder et al., 2024; Maulidyna et al., 2021). However, a research gap—namely, the under exploration of symbolic communication as a mechanism for transmitting ecological knowledge—remains significant. Most studies on agroecology and coastal fisheries tend to focus on technical, ecological, and economic dimensions such as catch efficiency, land productivity, or the application of conservation technologies (Majumder et al., 2024; Si et al., 2025). Only a few studies have examined how symbolic communication, through rituals, taboos, and cultural narratives, functions as a social mechanism that legitimizes ecological knowledge while ensuring the sustainability of environmental values in the lives of coastal communities (Sulaiman et al., 2023; Jumaidin et al., 2024).

This research attempts to address these theoretical and empirical gaps—particularly at the intersection of agroecology, environmental communication, and Islamic culture—to understand how the symbolic systems and cultural practices of the Bajau people can strengthen sustainable coastal ecological governance (Winchester, 2023). In the context of Muslim coastal communities, Islamic ecological ethics offers a rich moral foundation, yet it has not been widely applied in sustainability practices. The principles of *khalīfah* (human responsibility as stewards of the earth), *ḥifẓ al-biʾah* (environmental protection), and *mīzān* (cosmic balance) taught in the Qur'an and Hadith could serve as a conceptual basis for strengthening coastal agroecological practices. However, the application of these principles in community-based resource governance remains limited (Shah Haneef, 2024; Zuhdi et al., 2024; Kinoti, 2023). The integration of Islamic ethical values and local agroecological practices has the potential to enrich the conceptual framework of sustainability and bridge modern science with the ecological spirituality of Muslim maritime communities.

Based on this foundation, this study aims to analyze how symbolic communication and Islamic ecological ethics contribute to the sustainability of coastal agroecological systems in the Bajau community in the Tiworo Strait, Southeast Sulawesi. The specific objectives of this study include identifying forms of Islamic ecological wisdom and local agroecological practices institutionalized in Bajau community governance, analyzing the role of symbolic communication in maintaining ecological values, exploring mechanisms for intergenerational knowledge transmission, and assessing the potential of the Bajau symbolic and ecological systems as a model for community-based sustainable fisheries management.

The novelty of this research lies in the development of an integrative framework that combines symbolic communication and Islamic ecological ethics as regulatory mechanisms in a community-based coastal agroecological system. This approach repositions Islamic ethical values from moral norms to operational principles of resource governance, while interpreting symbolic communication—through rituals, taboos, and cultural narratives—as a system of social control that supports ecological sustainability. This synthesis highlights how symbolic and institutional mechanisms support the transmission of knowledge across generations and shape the socio-ecological resilience of the Bajau community. Conceptually, this research views coastal agroecology not merely as a biophysical system, but also as a communicative and ethical process that supports ecosystem resilience. Empirically, it demonstrates that symbolic expressions—such

as rituals and customary prohibitions—function as instruments of ecological governance and resource behavior regulation. Methodologically, it combines ritual ethnography with agroecological analysis as a new approach to the study of coastal resource management. Thus, this study expands the global discourse on agroecology and community-based resource management through the integration of ethical, symbolic, and institutional dimensions within an adaptive framework for Muslim coastal communities and provides a policy basis for strengthening community-based ecological practices in fisheries, climate adaptation, and sustainable rural development programs.

MATERIALS AND METHODS

***Research design*:** This research uses a qualitative ethnographic approach within a post-positivist paradigm. This paradigm recognizes that socio-ecological realities are constructed, partial, and contextual, yet can still be systematically examined with methodological rigor and critical reflexivity (Maxwell & Kiegelmann, 2023).

Ethnography was chosen because it allows for in-depth exploration of symbolic communication, local ecological knowledge, and coastal community practices through lived experiences, narratives, and rituals. This approach aligns with the research objectives, namely: (a) identifying value-based ecological wisdom and local agroecological practices relevant to sustainable agriculture; (b) analyzing symbolic communication as a regulatory mechanism in ecological governance; (c) exploring the intergenerational transmission of knowledge that underpins community-based resource management; and (d) assessing the potential of Bajau practices as a model for coastal resource management and adaptive rural development to climate change.

***Research location*:** Fieldwork was conducted in Muslim Bajau communities along the Tiworo Strait in Southeast Sulawesi, Indonesia. Administratively, the research area encompasses coastal villages in Napabalano District (Muna Regency) and the districts of Napano Kusambi, Kusambi, Tiworo Islands, North Tiworo, and Central Tiworo (West Muna Regency). The selection of these locations was based on the ecological diversity of the Tiworo Strait, which represents a complex coastal ecosystem (mangroves, seagrass beds, and coral reefs) and the richness of Bajau maritime traditions. These traditions encompass ritual practices, symbolic communication, and fisheries-based livelihood systems that have the potential to be transferred to agroecological and coastal resource management frameworks.

***Informants and sampling techniques*:** Informants were determined through purposive sampling of 31 key figures, consisting of: a) Religious leaders who instill ecological ethical values based on Islamic teachings; b) Ritual leaders/traditional elders (*lolo*) who manage collective rules, symbols, and taboos that regulate resource access; c) Environmental custodians who are responsible for local ecosystem conservation and protection practices; and d) Knowledge keepers who ensure the transmission of knowledge across generations.

This composition reflects the authority structure within the Bajau community, where Islamic values, customary norms, and ecological ethics are institutionalized in symbolic leadership mechanisms. This sampling strategy aligns with the research objectives: Objective (a) is addressed through interviews with knowledge keepers and religious leaders who understand Islamic ecological wisdom; Objective (b) focuses on customary leaders and rituals that govern symbolic mechanisms and collective regulation; Objective (c) is explored through community elders as key actors in intergenerational transmission; and Objective (d) is obtained from the perspectives of environmental guardians and community leaders who link ecological practices to rural development and coastal resource management.

Informants were evenly distributed across six sub-districts (Napabalano = 7; Napano Kusambi = 3; Kusambi = 4; Tiworo Islands = 6; North Tiworo = 7; Central Tiworo = 4). This balanced distribution strengthens contextual validity and ensures that the observed traditions, communication systems, and ecological practices represent a sustainable regional phenomenon, not merely local practices.

***Data collection techniques*:** Data were collected using three main techniques. First, in-depth semi-structured interviews with key figures, focusing on ritual practices, communication codes, Islamic ecological interpretations, and intergenerational narratives. Second, participant observation of rituals, community fishing activities, and daily ecological interactions to understand symbolic practices directly. Third, field documentation, in the form of field notes, audio recordings, photographs, and recordings of ritual narratives. Interviews were conducted in both Bajau and Indonesian, with cross-validation through source triangulation and field notes.

***Data analysis*:** The analysis was conducted using an interactive model (Kakar et al., 2023), consisting of five stages. First, data condensation: selecting and summarizing transcripts and field notes. Second, data presentation: organizing themes through matrices and conceptual maps. Third, categorization: grouping symbolic practices, communication codes, and ecological values. Fourth, interpretive synthesis: constructing narrative meaning from across informants and ritual contexts. Fifth, verification: through member checking, triangulation, and reflection with fellow researchers and local leaders.

Theme coding was conducted using open coding and axial coding techniques, with the assistance of NVivo 12 software to facilitate qualitative data management. Analysis focused on semiotic structures, ritual patterns, and intersubjective meanings, in line with the research objective of examining

symbolic communication in ecological governance. This approach aligns with recent reviews of qualitative methods in environmental and eco-social research, which emphasize the importance of integrating analytical techniques, software use, and ethical considerations (Caggiano & Weber, 2023).

***Data validity*:** The validity of this research was ensured by applying four qualitative trustworthiness criteria: credibility, transferability, dependability, and confirmability (Ahmed, 2024; Kakar et al., 2023; Nassaji, 2020; Yadav, 2022).

First, credibility was achieved through prolonged field engagement, persistent observation, and member checking with participants. Validation of interpretations was strengthened through peer debriefing, as recommended in contemporary qualitative research (Schlunegger et al., 2024).

Second, transferability was ensured by developing detailed thick descriptions of Bajau rituals, coastal ecology, and symbolic codes. This strategy enabled a deep understanding of the research context and its application to similar studies in other Muslim coastal communities (Ahmed, 2024; Nassaji, 2020).

Third, dependability was ensured through a documented audit trail, reflective memos, and methodological transparency. This effort aligns with the reliability-enhancing strategies recommended by Kakar et al. (2023) and Lim (2024).

Fourth, confirmability was established through data triangulation from in-depth interviews, ritual observations, and validation of interpretations with cultural actors. This step ensures that findings are rooted in empirical data, not researcher bias (Lim, 2024; Ahmed, 2024).

***Ethical Considerations*:** All research procedures adhered to international qualitative research ethical standards. Informed consent, both verbal and written, was obtained from all participants after explaining the purpose, voluntary nature, and right to withdraw at any time. Anonymity was maintained through the use of pseudonyms, and cultural sensitivity was observed when dealing with sacred rituals or esoteric knowledge. The involvement of community gatekeepers served to build trust, ensure ethical access, and reduce interpretive bias.

RESULTS

***Forms of Islamic ecological wisdom and local agroecological practices in bajau coastal governance*:** This study found that the Islamic ecological wisdom of the Bajau Muslim community on the coast of Tiworo, Southeast Sulawesi, is manifested in a set of practices, taboos, and rituals that integrate Islamic values with maritime customs. These forms can be categorized into three main domains: (1) traditional fishing practices and ethical behavior, (2) systems of taboos, sacred zones, and consumption prohibitions, and (3) marine conservation rituals as worship. These findings are not only anthropologically important but also relevant to the development of agroecology, marine-based food security, and natural resource governance—core issues in global agricultural innovation.

***Traditional fishing practices and ecological ethics*:** Fishing practices such as *palilibu* (seasonal sea hunting), *bapongka* (sea pilgrimage), and *sasakai* (collective fishing) reflect orally transmitted ecological knowledge, guided by religious norms. These practices serve a dual purpose: as economic strategies and spiritual expressions rooted in the Islamic concepts of *khalīfah* (trustworthy leadership), *ḥifẓ al-biʾah* (environmental protection), and *mīzān* (cosmic balance).

As one traditional leader put it:

"We don't fish carelessly. There are times and procedures that must be respected. That is the teaching of our ancestors, and part of our faith as Muslims" (Informant SN, Traditional Leader, North Tiworo).

This demonstrates that Bajau fishing practices are not merely subsistence but also a moral-spiritual obligation that reinforces a religiously based agroecological code of ethics.

***The pamali system, sacred zones, and consumption prohibitions*:** The Bajau implement *pamali* as a system of ecological-spiritual taboos, including prohibitions on fishing in sacred waters (*mbu*), prohibitions on consuming certain species during the spawning season, and prohibitions on entering certain zones without ritual permission. A community elder explained:

"Mullet cannot be caught while they are spawning. It is forbidden, not only according to custom, but also according to religion, because it disrupts the balance of nature" (Informants UD and SD).

Pamali functions not only as customary law but also as a theological imperative that strengthens communal ecological accountability. Thus, this system functions as a faith-based agroecological regulatory mechanism, preserving marine populations while transmitting ecological ethics to the younger generation.

***Marine conservation rituals as worship*:** Rituals such as *maduai pinah* (sea thanksgiving) and *sangal* (ritual fish release) demonstrate the ecological dimension of worship in Bajau coastal governance. These rituals emphasize the principles of *shukr* (gratitude), *istighfār* (forgiveness), and *amānah* (trust), positioning marine conservation as a form of devotion to God.

Beyond its spiritual function, rituals also have an ecological-pedagogical nature. Younger generations are taught that the sea is a sacred entity, not simply a marketplace. A cultural advisor stated:

"In the ritual, fish are named and prayed for. That is our message to God, and also to our grandchildren, that the sea is not a marketplace—the sea is sacred" (HT Informant, Cultural Advisor).

Thus, rituals serve as conservation instruments, intergenerational ecological education media and culture memory reinforcement. To clarify the conceptual framework, Table 1 summarizes Bajau Islamic ecological wisdom in

Table 1. Conceptual summary of Bajau Islamic ecological wisdom in coastal governance.

Domain	Key Practices	Islamic and Cultural Principles	Ecological/ Governance Function	Social/Pedagogical Role
Traditional Fishing Practices and Ethical Behavior	*Palilibu* (seasonal hunting), *Bapongka* (sea pilgrimage), *Sasakai* (collective fishing)	Caliphate (*Khalīfah)*, moral responsibility, respect for divine order	Sustainable harvesting, adherence to marine cycles	Instilling spiritual-ethical norms and strengthening the community's moral code
Pamali, Sacred Zones, and Consumption Taboos	Prohibitions in sacred waters (*mbu*), prohibitions on harvesting certain species, restricted zones	Divine authority, protection of ancestors, Islamic norms (*haram*)	Protecting fish populations, maintaining ecological balance, strengthening collective compliance	Educating the younger generation to respect sacred and ecological rules
Marine Conservation Rituals as Worship	*Maduai Pinah* (sea thanksgiving), *Sangal* (ritual fish release)	*Sukhr, Istighfar, Amanah, Mīzān*	Managing marine resources, affirming ethical fishing practices, linking practices to Islamic cosmology	Educational media, transmitting knowledge, strengthening cultural memory

coastal governance, including key practices, underlying Islamic and cultural principles, ecological and governance functions, and the socio-pedagogical roles they play.

Traditional fishing practices, taboo systems, and conservation rituals form an integrative ecological governance framework that unites spiritual norms, ecological ethics, and agroecological practices. This framework not only maintains the sustainability of marine ecosystems but also strengthens coastal food security and rural economies. Thus, Bajau Islamic ecological wisdom can be viewed as a locally based agroecological innovation that offers important lessons for natural resource governance in various global contexts. These practices also demonstrate how religious, social, and ecological dimensions intertwine to support sustainability.

***The role of symbolic communication in maintaining ecological values and guiding resource management*:** In Muslim Bajau communities, ecological ethics are not only internalized through Islamic teachings and customary law, but also through a complex system of symbolic communication. This system encompasses non-verbal gestures, oral narratives, rituals, and pamali (social prohibitions), which culturally and theologically reinforce respect for the ocean and coastal ecosystems. These mechanisms are transmitted across generations, shaping attitudes and behaviors aligned with agroecological principles—emphasizing the balance between humans, coastal agricultural lands, and marine ecology, as well as the principles of *taqwā* (God-consciousness), *amānah* (trust), and *ṣabr* (self-control).

***Ritual gestures and agroecological practices*:** Symbolic gestures form a "grammar" of ecological behavior that directly impacts agricultural practices and coastal resource management. An example is *Bembasa laut* (reading the sea conditions)—a ritual of silence before a sea voyage, instilling a respect for nature that is then reflected in coastal land conservation practices. Another example is Sangal, a ritual fish release that teaches the principle of resource restriction—which can be adopted in harvesting or managing marine products and coastal ponds. This is reinforced by the following statement:

"Being silent when starting a journey is not just superstition. Silence demonstrates good manners, because the sea is sacred and always listens" (Informants HA and HR).

"When we perform sangal, we release a fish to remind the sea that we come in peace. It's also a way to teach young people that not everything is ours to take" (Informant BD).

This gesture supports climate-smart agricultural practices on the coast, such as regulating cropping patterns or land rotation to maintain soil fertility affected by saltwater intrusion and tidal flooding.

***Oral narratives and agroecological education*:** Oral narratives such as *iko-iko*, proverbs, and ritual declarations transmit ecological knowledge while affirming Islamic interpretations of nature (*khalq*). These narratives serve as cultural pedagogy, guiding the behavior of farmers and fishermen toward sustainable practices:

"Our ancestors used iko-iko to teach us which fish to avoid, when to stop, and how to pray before going out to sea. These are not just stories—they are our laws" (Informant HI).

"Some of our proverbs about the sea—like 'if you take too much, it will return in a storm'—come from our elders and also from our religion. They are reminders that God is watching" (Informant RD).

These narratives form a moral framework for coastal agricultural practices, such as managing natural fertilizers, conserving coastal vegetation (mangroves, seagrass beds), and scheduling plantings according to the tides.

***Pamali-moral boundaries for resource management*:** *Pamali* define behavioral boundaries with emotionally powerful language, linking spiritual authority to conservation. These statements establish psychological boundaries that limit overexploitation, including in the context of coastal agriculture:

"Pamali is our way of reminding each other—especially the children—that the sea has rules. It's our way of saying, 'This action has consequences'" (SD informant).

"We say: 'Don't go where the sea is calm—angels are resting there.' That's how we teach boundaries, without a map" (HF informant).

Table 2. Forms of symbolic communication and their implications for the management of Bajau coastal agroecosystems.

Symbolic Medium	Practices	Islamic/Cultural Principles	Ecological and Agroecological Functions
Ritual Gestures	Silence before a sea voyage, offerings, touching the sea	*Taqwā*, *amānah*, *ṣabr*	Foster respect and patience; guide coastal land conservation practices and crop rotations
Ceremonial Actions	*Sangal* (ritual fish release)	*Khalīfah*, *mīzān*	Regulate resource extraction; transmit conservation knowledge across generations
Oral Narratives and Stories	*Iko-iko*, proverbs, ritual declarations	*Khalq*, *amānah*	Codify environmental regulations; enforce sustainable agroecological practices
Pamali (Taboos)	Prohibition on the exploitation of the sea and coastal vegetation	Divine authority, ancestral guardianship	Limit overharvesting; support soil health and coastal agricultural productivity

These boundaries translate into local agroecological practices, such as harvesting prohibitions during certain seasons or maintaining coastal vegetation to prevent erosion and improve soil quality.

***Symbolic systems as mechanisms for agroecosystem management*:** Ritual gestures, oral narratives, and taboos form an integrated symbolic communication system, functioning as a socio-theological infrastructure for resource management. This mechanism enables the Bajau people to balance the needs of coastal agriculture, marine conservation, and mangrove management—in line with the principles of agroecology and sustainable agriculture.

To understand how ecological values are embodied in daily practices, observations and interviews indicate that ritual gestures, oral narratives, and taboos form an integrated symbolic communication system. This system is not merely cultural or religious, but functions as a socio-theological infrastructure that guides coastal resource management. Through this mechanism, the Bajau people are able to balance the needs of coastal agriculture, marine conservation, and the protection of vegetation such as mangroves, in line with the principles of agroecology and sustainable agriculture.

Table 2 summarizes these forms of symbolic communication, along with the underlying cultural and religious principles, and their implications for Bajau coastal agroecosystem management.

Ultimately, the research confirms that the Bajau symbolic communication system—including ritual gestures, oral narratives, and taboos—effectively instills ecological ethics in coastal agricultural practices. Gestures such as ritual silence and fish release (sangal) establish social discipline that encourages sustainable resource management, while oral narratives and proverbs teach principles of conservation across generations.

These mechanisms directly facilitate agroecological practices, including harvest regulation, protection of coastal vegetation (mangroves and seagrass beds), and adaptation to saltwater intrusion or tidal flooding. Thus, symbolic communication not only maintains cultural and religious values but also serves as a strategic instrument for agroecosystem health and food resilience in coastal zones, relevant for sustainable agricultural innovation in coastal communities.

***Intergenerational knowledge transmission mechanisms for maintaining ecological practices and adaptive governance*:** Sustainable Bajau coastal management is not simply the result of individual experience, but rather the product of a living knowledge system passed down through structured social roles, family routines, and culturally embedded rituals. Unlike formal education or digital transmission, ecological ethics in Bajau communities are nurtured through intergenerational engagement rooted in faith, community, and everyday maritime life, which also has direct relevance to coastal agricultural practices and sustainable agroecosystem management.

***Traditional elders (lolo) as narrative authorities and ethical mediators*:** In the Bajau Tiworo Raya community, *lolo* (the term for elders used for traditional leaders) are seen as guardians of sacred knowledge, maritime memory, ecological ethics, and ritual authority. Their legitimacy is not solely based on age or lineage, but also on mastery of oral history, the ability to read sea signs, and the capacity to mediate socio-ecological conflicts. As Informant JD emphasized:

"The elders are like books to us. They keep everything—when to fish, what rituals to perform, and how to ask permission from the sea. Without them, we are lost."

Customary authority leaders play a crucial role in enforcing taboos, establishing spatial boundaries in sacred maritime areas, and resolving inter-family conflicts over maritime resources:

"If two families fight over a fishing spot, the lolo decides. They know the stories, the signs, the rules—things you can't learn from the internet" (Informant HS).

Additionally, they provide practical guidance for navigating environmental uncertainty, which directly impacts coastal management and coastal agricultural decisions:

"Sometimes the currents change without warning. The elders will say, 'Don't go out tomorrow—tonight will be the night of the spirit crossing.' We obey, because they understand more than just the weather" (Informant SP).

***Family-based learning and embodied participation*:** Knowledge transmission also occurs through daily family

Table 3. Mechanisms of institutional knowledge transmission and intergenerational learning in coastal management of the bajau tribe.

Domain	Mechanisms / Practices	Roles of Informants / Actors	Pedagogical Function / Governance
Elder Authority (*lolo*)	Oral history, ritual arbitration, enforcement of *pamal*i (islamic custom)	Traditional elders, traditional leaders	Guardians of marine memory and ethical norms; mediating conflicts; ensuring adherence to sacred marine zones.
Family-Based Learning	Embodied participation, imitation, shared daily routines	Parents, grandparents, extended family	Internalizing ecological ethics and spiritual behavior; fostering moral responsibility (*amanah*) and religious awareness (*taqwā*) in children.
Selective Media Utilization	Contextual use of mobile phones and digital content	Community members, ritual assistants	Protecting sacred knowledge from inappropriate dissemination; ensuring learning remains embodied, situational, and morally charged.
Cross-Generational Pedagogy	Ritual participation, storytelling (*iko-iko*), direct guidance	Traditional elders and adult family members	Transferring ecological knowledge and spiritual ethics; strengthening social memory and culture-based marine governance.
Monitoring and Compliance	Seafaring schedule guide, sacred zones, ritual participation	Traditional elders, experienced fishermen	Ensuring adherence to ecological and spiritual norms; preventing overexploitation; maintaining community accountability.

routines, where children learn through direct observation and participation, rather than through formal instruction. Practices such as sangal and other marine rituals teach principles of fish and mangrove conservation while building ecological awareness and moral character:

"…my grandfather taught me how to release fish for sangal. He didn't explain it like a teacher—he just showed me and said, 'This is how we give thanks to God.'" (Informant SG)

Children internalize amanah (moral responsibility) and taqwa (religious awareness) through imitation, observation, and participation in daily activities, including coastal agroecosystem management, mangrove maintenance, and sustainable agriculture.

***Selective media use and cultural sustainability*:** The Bajau people utilize technology and digital media selectively, maintaining the integrity of rituals and ecological knowledge: *"…You can't learn these things on Facebook. Our way requires the sea, the people, and the moment. Videos can't convey the same meaning." (HK informant)*

This approach ensures that ecological values and coastal agricultural practices remain deeply internalized, while protecting the spiritual and moral aspects of ecological learning.

***Integrated mechanisms for knowledge transmission*:** Overall, intergenerational knowledge transmission in Bajau communities occurs through a triadic structure: a) Elder Authority (*lolo*)—Narrative and ethical mediators, management of taboos, and supervision of sacred marine zones; b) Family-Based Learning—Direct participation, imitation, and daily routines; and c) Selective Use of Media—Separating sacred and profane domains in knowledge dissemination. Furthermore, intergenerational pedagogy includes rituals, storytelling (*iko-iko*), and direct guidance from elders and adult family members. These mechanisms ensure the internalization of ecological ethics, moral responsibility, and cultural sustainability, which are highly relevant for coastal governance, mangrove conservation, and sustainable agroecosystem management.

Table 3 presents a summary of the mechanisms, actor roles, and pedagogical strategies that support the transmission of institutional knowledge and ecological ethics in Bajau communities.

Figure 1 presents a conceptual framework for institutional knowledge transmission and intergenerational learning guided by Islamic ecological values, with symbolic communication at its center. This central node—through gestures, oral traditions, sacred expressions, and ritual interactions—connects social norms, environmental ethics, and cultural practices transmitted between generations. The diagram emphasizes Islamic ecological ethics (*khalīfah, ḥifẓ al-bīʾah, mīzān*) as the basis for ethical decision-making, while also highlighting social and family structures, where elders serve as narrative anchors, the family serves as a pedagogical space for the internalization of *amanah* (trust) and *taqwā* (obedience), and selective media use defines the boundary between sacred and profane knowledge.

This knowledge transmission process is supported by social learning theory, cultural transmission theory, and Islamic ecological principles (Alhinai & Ringer, 2025; Schniter et al., 2023). The results show that Bajau coastal management is a combination of spiritual values, agroecological practices, and adaptive governance, which has the potential to be applied to support the sustainability of coastal agriculture and global agroecosystems.

Sustainable Bajau coastal management emerges from a living, intergenerational knowledge system that integrates the authority of elders, family-based learning, and selective media engagement. Children internalize this ethic through direct participation in maritime and agricultural routines, learning ecological responsibility, moral accountability

(*amanah*), and spiritual sensitivity (*taqwā*). This approach supports adaptive coastal governance, sustainable fisheries, mangrove conservation, and agroecological farming practices, establishing a model for agroecosystem management that is resilient, culturally embedded, and relevant to sustainable agriculture and global coastal food security.

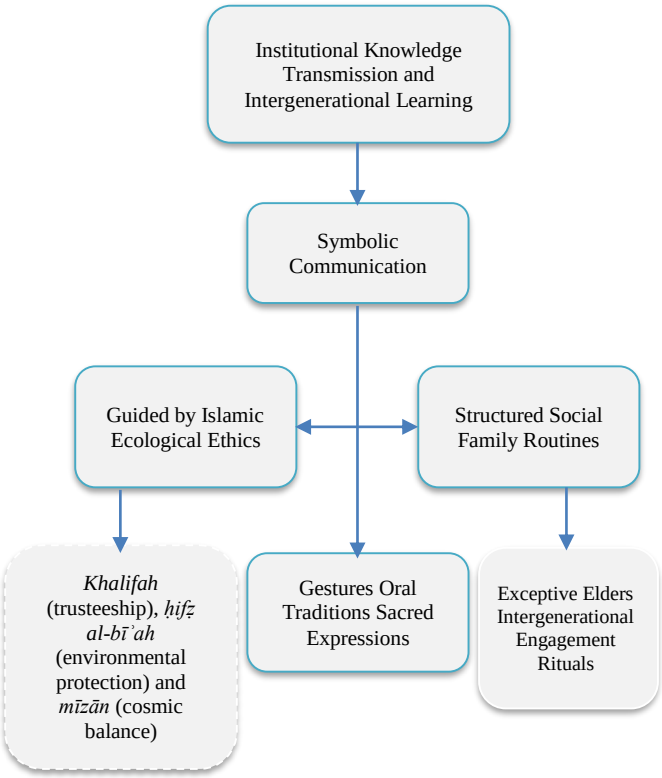
Institutional Knowledge Transmission and Intergenerational Learning
Symbolic Communication
Guided by Islamic Ecological Ethics
Structured Social Family Routines
Khalifah (trusteeship), ḥifẓ al-bīʾah (environmental protection) and mīzān (cosmic balance)
Gestures Oral Traditions Sacred Expressions
Exceptive Elders Intergenerational Engagement Rituals

Figure 1. Conceptual framework of institutional knowledge transmission and intergenerational learning in the Bajau community.

***The potential of bajau symbolic and ecological practices as a model for sustainable fisheries management and rural development*:** The analysis shows that the Muslim Bajau community on the coast of Tiworo, Southeast Sulawesi, has developed a fisheries and coastal agroecosystem management system rooted in Islamic values and local wisdom. These practices not only maintain ecological sustainability but also form social, moral, and pedagogical guidelines that enable adaptation across generations. The findings can be synthesized into three main domains.

***Islamic ecological wisdom and local agroecological practices*:** The Bajau community exhibits fishing practices, a system of taboos, and marine conservation rituals that integrate Islamic values with maritime customs, serving as economic strategies, spiritual expressions, and conservation mechanisms (Table 1). These practices are described in three aspects.

***First, traditional fishing practices and ecological ethics*:** *Palilibu* (seasonal hunting), *bapongka* (sea pilgrimage), and *sasakai* (collective fishing) reflect oral ecological knowledge guided by religious norms, aligned with the principles of *khalīfah* (trustworthy leadership), *ḥifẓ al-biʾah* (environmental protection), and *mīzān* (cosmic balance).

"We don't fish carelessly. There are times and procedures that must be respected. That is the teaching of our ancestors, and part of our faith as Muslims" (Informant SN, Traditional Leader, North Tiworo).

***Second, the pamali system, sacred zones, and consumption taboos*:** Prohibitions on fishing in sacred waters, harvesting certain species, or entering certain zones without ritual permission serve as faith-based agroecological regulatory mechanisms.

"Mullet may not be caught while they are spawning. It is forbidden, not only according to custom, but also according to religion, because it disrupts the balance of nature" (Informants UD and SD).

***Third, marine conservation rituals as worship*:** *Maduai pinah* (sea thanksgiving) and *sangal* (ritual fish release) emphasize the principles of *shukr* (gratitude), *istighfār* (forgiveness), and *amānah* (trustworthiness), while also serving a pedagogical-ecological function for the younger generation (Table 1).

***The role of symbolic communication*:** Ecological values are internalized through ritual gestures, oral narratives, and taboos, forming an integrated symbolic communication system that regulates sustainable behavior (Table 2). First, Ritual Gestures: Silence before going out to sea instills respect and conservation discipline. Second, Oral Narratives: *Iko-iko* and proverbs guide sustainable behavior and affirm Islamic interpretations of nature. Third, *Pamali*: Establishes moral boundaries for resource extraction and the protection of coastal vegetation. The following statement supports this:

"When we perform sangal, we release a fish to remind the sea that we come in peace. It's also a way to teach young people that we can't take everything" (Informant BD).

These symbolic mechanisms facilitate agroecological practices, including harvest regulation, mangrove protection, and adaptation to saltwater intrusion or tidal flooding.

***Transgenerational knowledge transmission*:**The sustainability of Bajau coastal management is maintained through a system of living knowledge passed down through generations: a) Elder Authority (*lolo*): Ethical mediators, guardians of marine memory, and supervisors of taboos (*pamali*), enforcing adherence to sacred marine zones; b) Family-Based Learning: Children learn through observation, participation, and imitation in daily routines and marine rituals; and c) Selective Media Use: Digital use is limited to maintain the integrity of rituals and sacred knowledge. Observations indicate that this combination instills ecological ethics, moral responsibility (*amānah*), and religious awareness (*taqwā*), supporting adaptive coastal governance,

mangrove conservation, and sustainable agroecosystem practices (Table 3, Figure 1).

Fishing practices, the *pamali* system, rituals, and symbolic communication form an integrative ecological governance framework, linking spiritual norms, ecological ethics, and local agroecology. The transmission of knowledge across generations ensures the sustainability of ecological ethics and coastal agricultural practices, making the Bajau community a model for agroecological innovation based on local and Islamic values, relevant for natural resource management and coastal food security globally.

DISCUSSION

The research revealed that the Bajau Muslim community on the coast of Tiworo developed a fisheries and agroecosystem management system that combines religious values, customs, and ecological practices. This discussion highlights three key dimensions that have proven to be foundational to the sustainability of local practices: Islamic ecological wisdom, symbolic communication, and intergenerational knowledge transmission. These three dimensions not only explain the success of local resource management but also open up opportunities for the development of sustainable management models relevant to agroecological practices, coastal conservation, and rural development (Asnaedi et al., 2025).

The first dimension, Islamic ecological wisdom, is reflected in traditional fishing practices, *taboo* systems, and marine conservation rituals that balance economic interests, resource conservation, and spiritual values. The integration of the principles of *khalīfah, ḥifẓ al-biʾah*, and *mīzān* enables communities to uphold ecological behavior while maintaining moral responsibility and religious awareness (*taqwā*) (Alhinai & Ringer, 2025; Rahmat et al., 2025; Basri et al., 2024). Marine conservation rituals, such as maduai pinah and sangal, have a pedagogical dimension, teaching younger generations to respect natural cycles and ethical principles, while strengthening food security and the rural economy (Maulidyna et al., 2021; Boni et al., 2024). This finding is in line with the literature which confirms that Islamic spiritual norms and ethical principles increase adherence to sustainable practices and support the development of local culture-based agroecology (Schniter et al., 2023; Yusuf & Marjuni, 2023; Gada, 2024).

The second dimension, symbolic communication, serves as a mechanism for reinforcing values and behavior. Ritual gestures, oral narratives, and taboos transfer ecological knowledge while affirming moral and religious values. The silence before going out to sea or releasing fish (*sangal*) creates collective behavioral norms that minimize overexploitation, while oral narratives, proverbs, and storytelling embed conservation principles within an Islamic moral framework (Jumaidin et al., 2024; Ajani et al., 2024; Canonizado, 2024). Symbolic communication not only maintains local wisdom but also serves as an adaptive instrument for coastal agroecosystems, enabling the integration of mangrove conservation, land rotation, and sustainable harvest management (Buenavista & Purnobasuki, 2023; Sulaiman et al., 2023). This approach aligns with the principles of sustainable agriculture and local food systems, which emphasize efficient, ecological, and socio-economic resource management (Schröter et al., 2020).

The third dimension, the transmission of knowledge across generations, is a pillar of sustainable Bajau coastal management. Living knowledge is passed down through the authority of elders (*lolo*), family-based learning, and selective media use, ensuring the internalization of ecological ethics, moral responsibility, and religious awareness (Canonizado, 2024; Mota et al., 2023). The elders' role as ethical mediators and guardians of marine memory reinforces adherence to customary norms and sacred marine zones, while children's participation in family routines and marine rituals builds local capacity for agroecosystem management (Zainuddin, 2023). The literature supports that cultural transmission through direct experience and the support of information media is more effective in shaping long-term (in this case ecological) behavior (McLeod, 2025; Bräuchler, 2023), relevant for ecological education, environmental literacy, and rural capacity building (Marshall, 2024).

Based on these three dimensions, Bajau practices show great potential as a model for sustainable fisheries management and rural development. Although the development of a fourth dimension—a systematic symbolic-ecological model for replication in other communities—has not yet been fully formulated, these findings open up avenues for research and policy innovation (Asnaedi et al., 2025; Kurniawati et al., 2025; Kinoti, 2023). This model aligns with research priorities in modern agriculture, agroecology, coastal resource management, and food security, making it relevant for sustainable practices in coastal communities with diverse cultural contexts, while also strengthening ecological, social, and economic resilience in rural areas (Rahmat et al., 2025). Furthermore, this framework is consistent with national regulatory and institutional directions, particularly Law No. 27/2007 (revised by Law No. 1/2014) concerning the Management of Coastal Areas and Small Islands, Law No. 32/2009 on Environmental Protection and Management, and the Ministry of Marine Affairs and Fisheries (KKP) programs on Community-Based Coastal Resource Management, which together emphasize participatory governance, ecosystem-based approaches, and the empowerment of local communities as central elements in sustainable coastal development.

***Conclusion*:** Research findings indicate that the Bajau Muslim community on the coast of Tiworo has developed a fisheries and agro-ecosystem management system that integrates religious values, local wisdom, and ecological

practices. The sustainability of these local practices is supported by three main dimensions: Islamic ecological wisdom, symbolic communication, and intergenerational transmission of knowledge.

Islamic ecological wisdom guides the community in balancing economic interests, resource conservation, and spiritual values through the principles of *khalifah*, *ḥifẓ al-biʾah*, and *mīzān*. Marine conservation rituals, taboo systems (*pamali*), and traditional fishing practices serve as pedagogical tools that instill moral responsibility (*amānah*), religious awareness (*taqwā*), and respect for the cycles of nature.

Symbolic communication, through ritual gestures, oral narratives, proverbs, and folklore, reinforces ecological and moral values. These mechanisms create collective behavioral norms, minimize overexploitation, and support adaptive coastal agroecosystem management, including mangrove conservation, land rotation, and sustainable harvest management.

The transmission of knowledge across generations is a pillar of sustainability, with elders (*lolo*) acting as ethical mediators and keepers of maritime memory, and families as spaces for hands-on learning. Children's participation in maritime and agricultural routines ensures the internalization of ecological ethics, moral responsibility, and religious awareness, while building local capacity for sustainable agroecosystem management.

Bajau practices show great potential as a model for sustainable fisheries management and rural development. This model integrates spiritual values, local wisdom, and symbolic-ecological practices, making it relevant for replication in other coastal communities, strengthening ecological, social, and economic resilience, and supporting agroecological development and global food security.

***Theoretical implications*:** The results of this study broaden our understanding of the relationship between religion, local culture, and natural resource management. The findings suggest that Islamic ecological wisdom, symbolic communication, and intergenerational knowledge transmission form a framework for sustainable, integrative ecological governance. Theoretically, this confirms that spiritual principles and moral norms are not only normative factors but also effective adaptive mechanisms in guiding ecological behavior, supporting coastal agroecosystem management, and shaping local capacity for sustainable agricultural innovation. This study also adds to the literature on agroecology based on local values and symbolic practices as a resilient ecological learning instrument relevant for coastal and rural communities.

***Practical implications*:** The research findings suggest that the Bajau management model can serve as a guideline for sustainable agricultural strategies and coastal conservation. Ritual practices, taboos, and storytelling internalize ecological ethics and religious awareness, enabling communities to manage resources adaptively without relying solely on formal regulations or high technology. The intergenerational transmission of knowledge ensures the sustainability of these practices, builds local capacity, and strengthens food security and the rural economy. This model can be adopted or adapted to other cultural contexts, particularly coastal communities facing ecological pressures and technological limitations.

***Policy Implications*:** This research provides recommendations for policymakers in the fields of agriculture, fisheries, and rural development. First, it is necessary to encourage recognition of local values and symbolic practices in coastal resource management planning. Second, the development of community-based ecological training and education programs can utilize the role of elders, families, and selective media as a means of knowledge transfer. Third, rural conservation and development policies should consider integrating moral-spiritual principles with agroecological practices to increase community compliance, strengthen socio-ecological resilience, and ensure the sustainability of natural resources. This approach is relevant for formulating global strategies that balance ecological, social, and economic aspects in coastal and rural areas.

***Research limitations and further research suggestions*:** This study has several limitations. First, the study was conducted only in the Bajau Muslim community along the Tiworo Strait in Southeast Sulawesi, so the findings may not be fully generalizable to other coastal communities with different cultural, religious, or ecological contexts. Second, data were collected from 31 purposively selected key informants, so the perspectives of other groups, such as women, youth, or marginalized subgroups, may not have been fully represented. Third, the study relied heavily on qualitative reports through interviews, oral narratives, and participant observation, which are potentially subject to recall bias, social desirability bias, or differences in interpretation. Fourth, field observations were conducted over a limited period, so seasonal variations in fishing practices, agroecosystem management, and rituals may not have been fully observed. Fifth, the Bajau community's selective use of digital media limits our understanding of the interaction between modern technology and traditional ecological knowledge.

Future research recommends conducting comparative studies in other Muslim coastal communities or non-Bajau groups to assess the transferability of Bajau practices, expanding the sample of informants to include women, youth, and other groups for a more comprehensive cross-generational understanding. Conduct longitudinal studies that include seasonal variations; integrate quantitative ecological or agricultural indicators to validate the effectiveness of symbolic and ritual practices; examine the influence of modernization, technology, and climate change on traditional

ecological knowledge; and explore the application of Bajau practices in coastal resource management policies and sustainable agricultural adaptation strategies.

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***Availability of data*:** Field data, documents, and supporting materials for this research are available upon direct request to the author. The author is willing to provide any relevant additional information to support the verification, replication, and transparency of the research results.

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